

*G. Hosack Esq.-
With A. L. Light's compliments
and kind regards*

PROPOSED BRIDGE

OVER THE

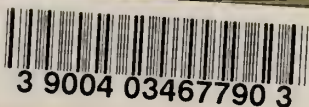
ST. LAWRENCE, AT QUEBEC.

[Reprinted from *ENGINEERING* of April 3, 1885.]

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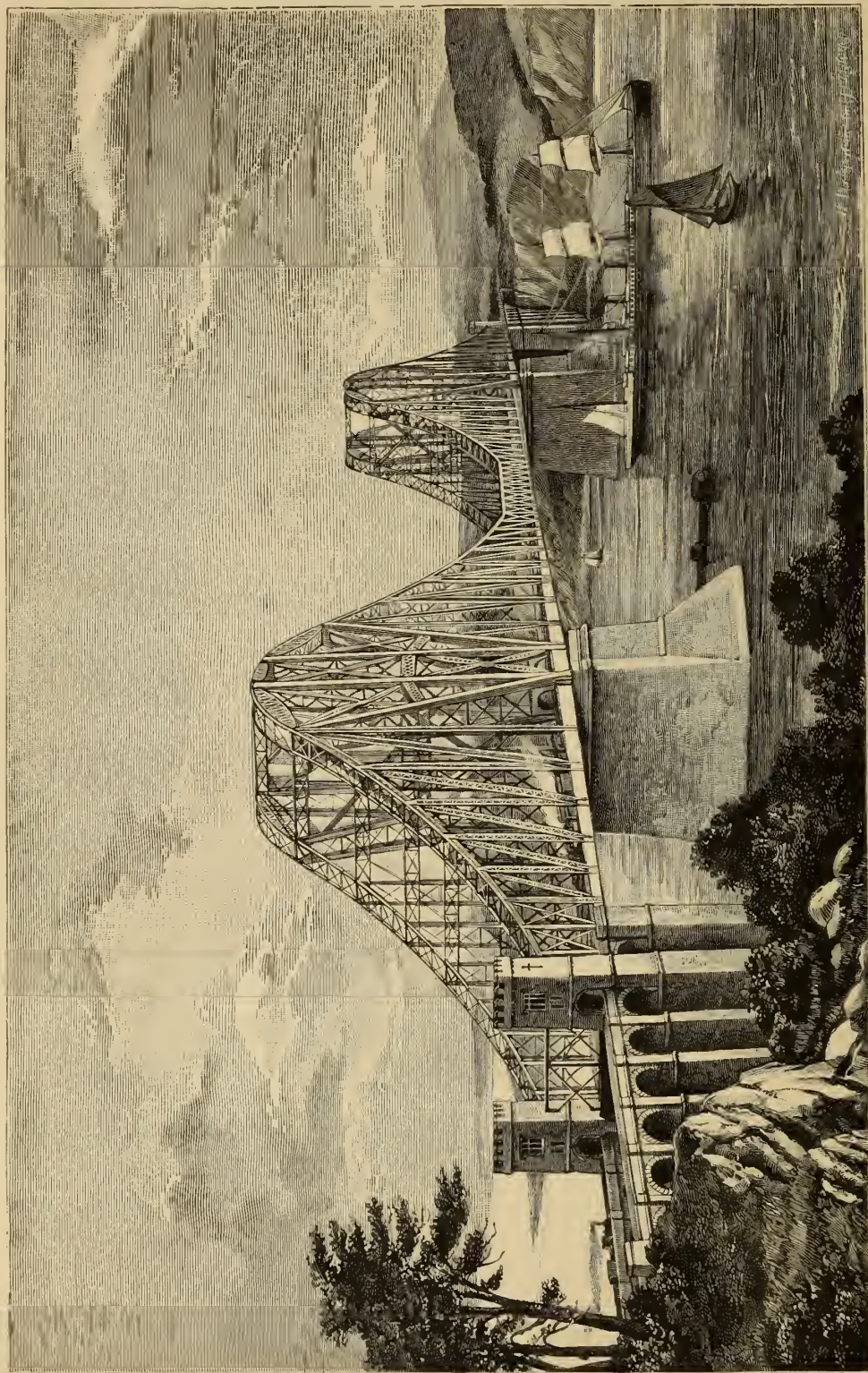


The EDITH *and* LORNE PIERCE
COLLECTION *of* CANADIANA



Queen's University at Kingston

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WE are informed that the Canadian Government have sanctioned the proposal to construct a railway bridge across the St. Lawrence within a few miles of Quebec. It has long been recognised that a railway communication across the river at this point would be of incalculable benefit, and that the junction of the railway systems on opposite sides of the river would effect a great change in the inland communications and transport of the whole country.

The engineering difficulties which have to be surmounted are undoubtedly great; the width of the central or main opening cannot be reduced to less than about 1440 ft., while the channel which has

thus to be crossed is, in summer time, the highway for the largest ocean steamers, and on the breaking up of the ice after the winter season, this narrow gorge is the scene of a tremendous "choke," the great masses of ice brought down from the wide reaches and lakes above, becoming concentrated in this narrow exit in such a way that they frequently pile themselves up to a height of 50 ft.

But with the resources which are now at the command of the engineer, and especially in view of the greater facilities afforded to bridge building by modern improvements in steel manufacture, there appears to be no reason why these difficulties should not be successfully overcome.

The engineers of the proposed bridge are Mr. James Brunlees and Mr. A. Luders Light, with whom Mr. T. Claxton Fidler is associated as joint assistant engineer.

We are indebted to the engineers for the illustrations of the bridge* (the originals of which will be shown at the Inventions Exhibition) which we publish, and on a two-page plate, in the present issue.

Site.—At the point selected for the site of the bridge, the River St. Lawrence narrows like a bottle-

* In order to give a more readily appreciable idea of the scale, the Orient steamer Austral, 455 ft. in length, is drawn to scale under the central span in the general elevation; the same vessel is shown by geometrical perspective in the perspective drawing of the bridge on the present page.

neck to a width of 2390 ft. at high water ; and of this space a great width of shore on each side is either dry at low water, or shelves only to a moderate depth ; but for a width of about 1400 ft. the bottom shelves rapidly into deep water, and in the centre the channel attains a depth of nearly 200 ft. The foundation is of rock and the piers of the channel span have been located at the farthest points consistent with due facility in executing the water foundations ; and at their inner edges will stand in a depth of about 24 ft. of water at low water.

Ice Choke.—To provide against the drift of ice the two piers are constructed with massive masonry ice-breakers rising to a height of 60 ft. on the upstream face of each pier. The total area of waterway at high water is at present about 200,000 square feet, and of this quantity not more than $4\frac{1}{4}$ per cent. will be obstructed by the proposed piers. At low water the area of waterway is about 160,000 square feet, and the obstruction of the piers is not more than $2\frac{1}{2}$ per cent.

Construction.—The proposed bridge will consist of three principal spans, in addition to several land arches, which form an approach to the bridge from the high ground on each side of the valley. The central or “channel” span, will have a clear width of 1442 ft., the underside of the superstructure being carried across this span at a nearly uniform

height of 150 ft. above high water. The bridge is designed upon the cantilever principle and will be constructed entirely of steel. The total length of the steel superstructure is 2800 ft., consisting of two main cantilevers and a short lattice span carried between them. The cantilevers are formed with the lower member horizontal, and the upper or tension member rising in two parabolic or nearly parabolic curves from each end towards the pier, at which point the cantilever attains its maximum depth of 258 ft. By this curvature the upper tension member takes up the greater part of the shearing stress, and the tall pillars of the web-bracing are subjected only to a very moderate compressive strain. At the pier the load is brought down upon the bearing point in four converging lines—or in other words the reaction or supporting force of the pier is distributed by four great steel struts or pillars radiating from the top of the pier like the spokes of a wheel segment, of which the upper member forms the rim; so that over the pier the upper member is curved in a reverse curve or polygon tangential with the concave or sagging curve which extends to each end of the cantilever. The effect of this reverse curvature of the upper member, is first to relieve the tall slender pillars of the web-bracing, and then to distribute the great shearing stress at the piers equally between all the four great radiating struts or pillars. The land end of each

cantilever is anchored vertically down to a masonry tower—or rather a group of four towers united by arches. The anchorage, which has to counter-balance the weight of the lattice span and of the central rolling load, is effected at the extreme end of the cantilever; but the girder takes a bearing first upon the inner pair of towers. One of the objects of this arrangement is to establish a positive bending moment over the inner towers, in order to prevent the insistence of a compressive stress which would otherwise take place in the upper member under a certain unequal distribution of the rolling load.

Wind.—Having now described the general elevation of the bridge and the action of the load in the vertical plane, it becomes necessary to refer now to the cubic form of the structure, and the action of the horizontal or wind forces, which in this case are quite as important as the vertical forces. The whole superstructure may be described as consisting of two single-line railway bridges spaced at a lateral distance of 90 ft. centre to centre and braced together; and here it may be mentioned that in like manner the approaches to the bridge consist of two single-line viaducts in parallel lines 90 ft. apart, each viaduct being formed of six masonry arches of 40 ft. span, and 150 ft. high, terminating in the group of towers before referred to. Reverting, however, to the wind strains, the bridge, as a wind girder, will constitute, not a cantilever bridge, but

a continuous girder bridge with only one fixed point of contrary flexure; it will be, of course, a bridge of three spans, and the wind girder will have a uniform depth (*i.e.*, breadth of floor) of 90 ft. from centre to centre of flanges, or about 108 ft. over all. And it is intended that the severance of the flanges of the wind girder, which is necessary to provide for expansion, shall be located as nearly as practicable at one of the natural points of contrary flexure of that continuous girder. This arrangement has been dictated by a careful consideration of the questions involved in the deflection of the wind girder as offering the most solid and substantial construction, as regards wind forces, which it is possible to adopt. The plane of the main wind bracing is at the level of the railway, the lower members of the cantilevers forming the flanges of the wind girder. With regard, now, to the upper wind forces; in the first place the towers are of course rigidly braced in transverse and horizontal planes; then the upper members of each single-line cantilever are united by upper wind bracing, forming wind girders about 17 ft. in depth, by which the forces are transferred to certain intermediate points of support, which are provided by the construction of transverse frames of bracing, by means of which the upper wind forces are transferred to the leeward cantilever, the canting moment of the upper wind forces being added to the load

and provided for in the calculated strains and strength of each cantilever.

Erection.—The side spans of the bridge, being almost entirely dry at low water, it will be practicable to erect staging for the temporary support of the bridge at any required points between the river piers and the abutments. When the main towers have been erected, it will not be very difficult to carry a temporary wire cable across the whole span, which would have a clear width of 1240 ft. across the central opening, and a versine of about 190 ft., following nearly the line of the upper member of the cantilever. From this cable, or set of cables, temporary scaffolding may be suspended, which of course will not be required to carry the weight of the cantilevers, but will be of great assistance in the piecemeal construction of the individual members, the erection of the upper tension member from point to point, the building of the web pillars, and so on. The cantilever will of course carry its own weight as it is progressively built out, but the suspension cable will serve to support a scaffold from which the detailed operations may be more conveniently carried on. The lower member of the cantilever, being horizontal, it will be practicable to push forward the side girders, length by length, by the process of rolling forward. The wind bracing will be made good progressively with the construction of the canti-

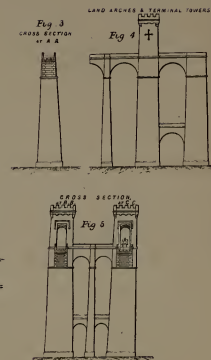
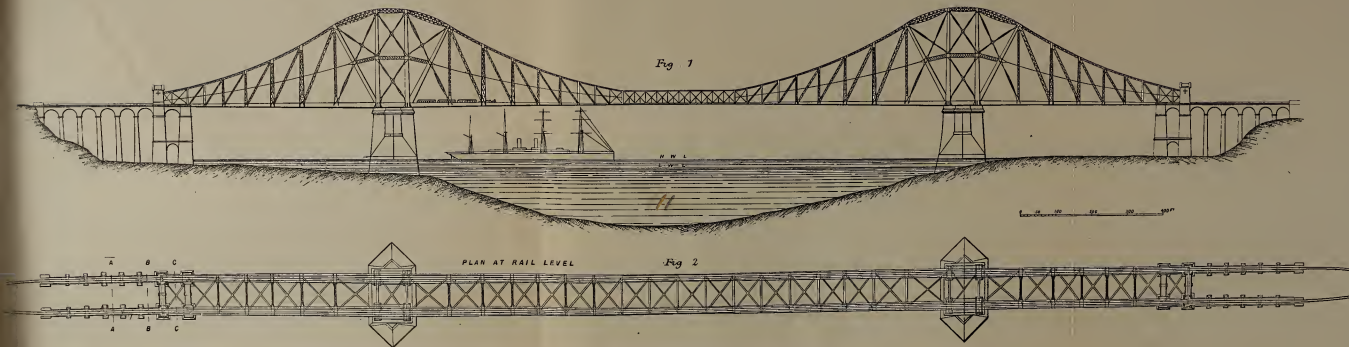
levers; and finally for the erection of the intermediate span, it will be open to the constructors to select from several alternative methods—either by overhead suspension making use of the temporary cables, by erection upon staging carried upon the ice in winter, or by rolling over from each side towards the centre.

Strength.—The bridge is designed to carry the heaviest railway traffic covering the whole extent of both lines of railway; and in view of the exposed position of the bridge, a wind pressure of 56 lb. per square foot has been provided for. The greatest stress in any of the steel members of the bridge will be $7\frac{1}{2}$ tons per square inch of sectional area, which is reduced in long struts, and in the members of the wind bracing exposed to alternating strains in opposite directions; in the latter case the stress is generally not more than 5 tons per square inch.

PROPOSED BRIDGE OVER THE RIVER ST. LAWRENCE, AT QUEBEC.

MR. JAMES BRUNLEES, MR. A. LUDERS LIGHT, AND MR. T. CLAXTON FIDLER, ENGINEERS.

PLATE I.



ENLARGED ELEVATION OF CANTILEVER

PLATE II

Fig 6

CROSS-SECTION AT RIVER PIERS.

Fig 7

0 50 100 200 300 400 FT

PRINCIPAL DIMENSIONS.

TOTAL LENGTH OF BRIDGE INCLUDING LAND ARCHES	3460 FT.
" " STEEL SUPERSTRUCTURE	2800 "
WIDTH OF STEEL SUPERSTRUCTURE	108 "
LENGTH OF CHANNEL SPAN, CENTRE TO CENTRE OF PIERS	1550 "
LENGTH OF CHANNEL SPAN, IN THE CLEAR	1442 "
CLEAR HEIGHT OF CHANNEL SPAN ABOVE HIGH WATER	150 "
MAXIMUM DEPTH OF CANTILEVER, AT PIERS	258 "
WIND PRESSURE ASSUMED, PER SQUARE FOOT	56 LB.
MAXIMUM STRESS IN STEEL MEMBERS, PER SQ. IN.	7.5 TONS
" " MEMBERS OF WIND BRACING	5.0 "

